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ABSTRACT

To establish an attribute by treatment interaction (ATI) between anxiety, stress, and response mode to programed instruction, a research design was used which consisted of two experimentally manipulated variables, stress and response mode, and two variables assigned on the basis of test score: the facilitating and debilitating anxiety scores of the Achievement Anxiety Test. A total of 144 college students were randomly assigned to a stress, or nonstress group, and to one of three response modes: constructed response with, and without reinforcement, or to a reading group. The learning materials consisted of a linear program dealing with the area of heart disease. The program contained material both familiar and unfamiliar to students. Posttests on both types of content were administered immediately after the program, and the data were analyzed by multiple linear regression. A strong positive relationship between facilitating anxiety and achievement on the technical program was found. Facilitating anxiety also interacted with stress and response mode for technical material. Debilitating anxiety failed to interact with any of the variables for technical material, though an interaction with stress for familiar materials was found. (Author/SP)

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The Relationship of Anxiety, Response Mode, and Content Difficulty to Achievement in Programed Instruction

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Summary

The basic aim of this study was to establish an attribute by treatment interaction (ATI) between anxiety, stress, and response mode to programed instruction. Subsidiary purposes of the research were to replicate previous findings concerning the effect of the mode of responding on achievement from programed instruction, and to study the effect of facilitating in addition to debilitating anxiety. The research design consisted of two experimentally manipulated variables, stress and response mode, and two variables assigned on the basis of test score: the facilitating and debilitating anxiety scores of the Achievement Anxiety Test.

A total of 144 Ss were randomly assigned to a stress, or non-stress group, and to one of three response modes: constructed response with, and without reinforcement, or to a reading group. The learning materials consisted of a linear program dealing with the area of heart disease. The program contained an easy section (4% error rate) dealing with material generally familiar to Ss, and a more difficult section (25% error rate) covering technical content unfamiliar to Ss prior to studying the program. Posttests on both types of content were administered immediately after the program.

The data were analyzed by multiple linear regression. A strong positive relationship between facilitating anxiety, and achievement on the technical program was found. Facilitating anxiety also interacted with stress and response mode for technical material. Debilitating

anxiety, however, failed to interact with any of the variables for technical material, though an interaction with stress for familiar materials was obtained. Finally, previous findings regarding the higher achievement of the constructed response mode for technical, but not familiar, subject matter were replicated.

The findings involving facilitating anxiety were conceptualized in terms of achievement motivation, which may be a promising variable in ATI research. The superiority of the constructed response mode on technical material was interpreted in terms of a response learning paradigm. In situations where responses are not in the repertory, constructing the responses, in terms of answers to an instructional program, may well lead to superior achievement. Where the responses are in the repertory but need to be associated to a new stimulus situation constructing the answers may lead to no higher achievement than other response modes.

The negative findings concerning debilitating anxiety on difficult, technical content raised questions regarding the size of the error rate required to evoke, and/or maintain anxiety. It was suggested that anxiety might interact with instructional mode only in the presence of error rates exceeding 60%. If this analysis is supported, ATIs involving anxiety will continue to be of some theoretical interest, though hardly pertinent for research involving optimal instructional methods.

Introduction

The adaption of instructional methods to individual differences among pupils is an area of some importance to education. In order to assign a pupil to the instructional method which would result in optimal achievement for him, an interaction is presumed to exist between the instructional strategy and the individual difference variable. Such an interaction would permit one to have some confidence in the assignment of a particular pupil who is high on a specific attribute to one instructional method and a second pupil who is low on that attribute to an alternative method. A serious research effort is, thus, required to establish interactions between a variety of individual difference variables and instructional strategies in order to permit the successful assignment of pupils to different instructional modes. The aim of the present report was to study such an interaction between anxiety, stress, content difficulty, and different instructional methods in the area of programed instruction.

Review of the Literature

The aptitude by learning treatment interaction (ATI) has recently become the focus of increasing attention (Carroll, 1969). Since such investigations are concerned with a whole array of variables along which individuals differ, and the term aptitude has been closely identified with the cognitive domain, it has been suggested (Tobias, 1969b) that a more appropriate description of this area would be the

attribute by treatment interaction, also giving rise to the now familiar ATI abbreviation.

Cronbach and Snow (1969) reported what is perhaps the most extensive review of ATI research. They concluded that a substantial research effort was needed in order to establish ATIs as a viable construct in the area of instructional research. This conclusion was not dissimilar to that reached by Glaser (1967, 1968) after he reviewed the learning literature dealing with ATIs.

In a review of ATI research using programed materials to implement different presentation strategies, it was concluded (Tobias, 1969b) that ATIs with different programing variables had also not been demonstrated. It was suggested that the assumption that a variable was actually operative in the research situation on the basis of a test score may have been largely responsible for the negative results reported in this area. In the area of anxiety, for example, the assumption that a subject (S) is as anxious about his performance on a brief research task as he is about his day-to-day activities or his performance on important examinations might well be unwarranted (Tobias & Williamson, 1968). It was recommended that future research assure that the variable being investigated was operative during the research task by combining experimental variation with the assignment of a variable on the basis of test score. This review also indicated that personal attributes which had an effect on achievement in one content area might not have the same effect in another area and that therefore Ss ought to be required to work on more than one

type of subject matter.

This study attempted to test this reasoning by employing both measured anxiety and experimentally induced stress, together with different modes of responding to programed materials. Content characteristics were also varied by employing materials of differing familiarity to the subjects.

Response Mode to Programed Instruction

The literature regarding achievement differences attributable to variations in the mode of responding to programed materials was reviewed by Anderson (1967), and by Tobias (1968). It was noted that no achievement differences were found in early studies comparing different response modes. Whether S responded to a program by constructing his responses and then checking their accuracy (constructed response), "thought" the answer without actually constructing his response (covert response), picked the answer from one of several available choices (multiple choice), or read the program cast in the form of completed statements (reading mode) resulted in comparable achievement.

Holland (1967) suggested that the prevalence of findings of no difference among response modes could be attributed to the programs employed in these investigations. Specifically, studies reporting no differences employed programs with high "black out" ratios. The black out ratio was defined as the percentage of words in a frame which could be eliminated, or balcked out with a crayon, without significantly increasing the program's error rate. Holland reasoned that these

materials were, strictly speaking, not programs since the blackout ratio indicated that content was introduced without becoming response contingent. Studies in which the constructed response mode did lead to higher achievement typically utilized programs in which the blackout ratio was low.

A different formulation regarding the findings on the response mode issue appears possible. Tobias (1969c) suggested that for content with which Ss have a good deal of prior familiarity no difference among response modes was to be expected. On the other hand, content which was new to Ss typically resulted in superior achievement with the constructed response mode. This position is in accord with the findings of a number of investigators. Cummings and Goldstein (1962), and Williams (1963, 1965) found evidence for the superiority of the constructed response mode using programs whose content was described as technical. It appeared likely that, in this context, technicality meant that S did not have the opportunity to become familiar with the content covered before studying the program.

The familiarity interpretation grew out of two studies (Tobias, 1969a, 1969c) employing instructional materials for which Ss had varying prior knowledge. A program was used covering both technical content unfamiliar to Ss, and material to which they had substantial prior exposure. Both sets of content were drawn from the same domain, the area of heart disease. The familiar portion of the program contained material dealing with the incidence of heart disease, and risk factors for contracting heart disease such as high cholestoral,

smoking, age, etc. The technical, unfamiliar section of the program dealt mainly with the diagnosis of myocardial infarction from the fifth precordial lead of the electrocardiogram. Technical names for different degrees of severity of coronary disease, electrocardiographic tracings characteristic of each level of severity, and graphic representations of the damage to the heart muscle caused by the various levels of coronary disease were included in this part of the program.

The findings of these investigations (Tobias, 1969b, 1969c) were in accord with the familiarity formulation. For familiar content, there was no difference between the constructed response group and Ss who read the materials. For the technical, unfamiliar subject matter significant differences occurred for test units requiring either a verbal or a pictorial response. An interpretation of these data in terms of the blackout ratio appears possible, though unlikely. The blackout ratio for the familiar materials, on which response modes did not differ, was higher than the ratio for the technical content. On the other hand, the blackout ratio of 24% for the familiar materials was not very high and similar to some programs reporting achievement differences between response modes (Holland, 1967).

The findings of Karis, Gilbert and Kent (1968) were also in accord with the familiarity notion. These investigators employed a technical program dealing with medical subject matter, and found that the constructed response mode led to significantly superior achievement. When synonyms for technical names were scored as acceptable answers

and responses could be paraphrased in nontechnical language, the superiority of the constructed response mode disappeared. These findings suggested that as Ss could bring their prior learning to bear on the task, i.e., when the task relied more on previously learned material, there were no differences between response modes.

Daniel and Murdoch's (1968) data also support a familiarity interpretation. These investigators found that a group studying Holland and Skinner's (1961) program achieved more than a group studying the same subject matter using Skinner's non-programed writings. The difference was based on a multi-variate analysis of variance using six different achievement indices as dependent measures. When the subtest measuring knowledge of specific content in the area of operant psychology was eliminated from the dependent measures by covariance adjustment the difference between the groups was no longer significant. These results indicate that the overall group differences hinged on the specific content subtest and, furthermore, that specific knowledge of operant terminology was probably that part of the material originally least familiar.

Roderick and Anderson (1968) found that the achievement of high school seniors on the Holland and Skinner (1961) program was superior to that of a group reading the same material summarized into succinct textbook-like passages. However, for a group of college sophomores, juniors, and seniors enrolled in an educational psychology course there were no achievement differences between the two versions. It seems likely that the latter group had a greater familiarity with the concepts

of operant psychology than did the high school students, especially since general psychology is typically pre-requisite for most educational psychology courses.

It is not unreasonable to assume that content with which Ss are unfamiliar may require a more overt response for optimal learning than does familiar subject matter. Lack of familiarity implies that the responses required by the task may not be in S's repertory, and consequently, actually making the response may well be the best way of mastering it. For familiar subject matter, on the other hand, overt responding may not be important since many of the required responses may well be in the repertory, though perhaps not in the specific context required by the material. In such a task S does not have to learn how to make the response, but rather how to connect existing responses to new, or different situations. Overtly making a response which is already in the repertory may not strengthen its association to new situations to any greater degree than covertly thinking, or reading the material. In terms of response mode, this formulation suggests that for content in which the required responses have been previously learned little achievement difference is to be expected between overt or covert responding, choosing from one of several alternatives, or reading the material. When the responses required by a program are new, actually making an overt response and receiving knowledge of results concerning it, is likely to lead to superior achievement.

A second purpose of the present investigation was, thus, to replicate earlier findings regarding the relationship between

familiarity with subject matter and response mode to programed instruction.

Anxiety

There is a strong rationale for the relationship between anxiety and achievement from programed instruction. Specifically, it would seem that the tight organization, reduction of uncertainty, and high ratio of reinforcement which characterize most programed materials should be especially advantageous for the achievement of anxious students. It is, therefore, surprising to note that the research reported relating anxiety to programed instruction largely fails to support these expectations.

Kight and Sassenrath (1966) found that anxious Ss worked faster and made fewer errors on a linear program dealing with test construction than less anxious students. No achievement difference, however, was reported between the groups. Flynn and Morgan (1966) used a 2 X 3 analysis of variance, with programed and conventional instructing defining the first variable, and three anxiety groups the second, to study the effects of anxiety on achievement. No significant main effects or interactions were found.

Lache (1967) also studied the effects of three levels of test anxiety on achievement. The sample was divided into two ability groups. A linear program in vocabulary was presented in four different ways: constructed response, optional constructed response, covert response, and the reading version. Again, analysis of variance of this 4 X 3 X 2

design revealed no significant main effects or interactions.

Tobias and Williamson (1968) divided college student Ss into two anxiety groups on the basis of scores on the Taylor Manifest Anxiety Scale. A linear program dealing with binary numbers was presented in three ways: constructed response with and without reinforcement, and in a reading version. An analysis of covariance of this 2 X 3 design, with the pretest score as a covariate, revealed no significant main effects or interactions for achievement or attitude data.

Campeau (1968) reported a significant interaction between anxiety and feedback in programed instruction. High anxiety girls achieved more than the low anxiety group in a standard constructed response with reinforcement condition. When the reinforcement was removed, however, the achievement of the lower anxiety Ss exceeded that of the high anxiety group. There were no significant effects for two similar groups of boys. These findings are difficult to evaluate for two reasons: First, Campeau's dependent measure consisted of gain scores from pre- to post-test. The difficulty of interpreting such data are outlined by Cronbach and Furby (1969), and by Harris (1963). Second, no data concerning performance on the program, such as error rates or time required to complete the program are reported. In the absence of such information inferences regarding the degree to which anxiety was operative during the research situation are purely speculative.

Several important factors in research on anxiety in other areas have not been studied in the context of programed instruction. Thus, investigations have typically sought relatively simple effects.

Typically, an anxiety scale was administered and different programing formats implemented. Prior investigations have not taken account of some of the complexities reported in experimental investigation of the relationship between anxiety and learning. Thus, Campeau took note of the fact that previous investigations had found sex to be an important variable in investigations of anxiety (Sarason, 1963; Lunneborg, 1964). Inspection of the grand means of her data suggests that had the analysis not considered the sex variable, significant differences would probably not have been found.

Several other factors of importance in previous investigations relating anxiety to learning have not been studied in the context of programed instruction. One of these is the relationship between anxiety and subject matter difficulty. According to the drive theory proposed by Spence (1958) and Taylor (1956) high anxiety should interfere with performance on complex tasks for which S's incorrect responses are of. equal, or higher, strength than the correct responses. For simpler tasks, where one predominant response exists relative to other responses, anxiety is predicted to have a facilitating effect. Empirical support for these formulations have been reported by a number of investigators (Spence, 1964; Denny, 1966; Spence & Spence, 1966). No investigations have been reported relating anxiety to achievement from programed instruction which varied the difficulty level of the material to be learned.

Another frequently reported finding in the anxiety literature was an interaction between anxiety and stress. Differences between

high and low anxiety groups occurred only under conditions of stress (Nicholson, 1958; Sarason & Palola, 1960; Sarason, 1958). When stress was absent, no anxiety effects were observed. As previously suggested, these findings reemphasize the importance of coupling a variable assigned on the basis of test score with an experimental variation to increase the probability that the variable studied is operative in the research situation.

The purpose of this study was to investigate some of these anxiety effects in a meaningful learning context using programed materials. Specifically, it was expected that there be no main effects attributable to anxiety but, instead, that anxiety would interact with situational stress. Furthermore, a triple interaction was predicted between anxiety, stress, and response mode. Constructed response was expected to be least affected by anxiety and stress, and providing no reinforcement most affected by it. Finally, the anxiety effects were expected to decrease learning on difficult materials, where, on simple content achievement was expected to increase.

Achievement Anxiety Test. The anxiety measure utilized in this investigation was Alpert and Haber's (1960) Achievement Anxiety Test (AAT). The AAT is composed of two subscales: the AAT+ deals with the kind of anxiety that facilitates performance in achievement situations, and the AAT- items tap the debilitating effects of anxiety on performance in achievement situations.

The choice of the AAT as a measure of anxiety in this investigation was prompted by several factors. First among these was the

evidence closely relating this test to achievement situations. Alpert and Haber (1960) reported that the AAT scales had the following multiple correlations with academic achievement in three different samples: .54, .50, .32. Correlations between the AAT- and achievement in these three samples were -.48, -.45, -.08; correlations for AAT+ being .32, .36, and .50. These correlations were relatively unaffected by scholastic aptitude. Retest reliability of the scales was .83 and .87 over a ten week interval.

The second factor prompting choice of the AAT was the fact that relationships similar to those obtained by Alpert and Haber were found in a pilot study. The AAT was administered to four educational psychology classes at the City College of New York during the Spring, 1967 semester. Correlations between the AAT+ and grade point average were .21, and -.26 between the AAT- and grade point average. The multiple correlations between both scales and grade point average was .45. When ability, as reflected by SAT scores, was partialled out the multiple correlation was only slightly reduced to .35. These results indicated that for the population to be used in the present investigation the evidence supported the contention that the AAT was related to anxiety associated with achievement situations.

Finally, the AAT was adopted because prior data suggested that it might interact with response mode to programed instruction. Subsidiary analysis of previous data (Tobias, 1969c) indicated that the AAT scales had the following correlations with total achievement from an instructional program in a reading condition: AAT+ = .40; AAT- =

-.28. In a constructed response condition, however, the correlations were .08 for the AAT+, and -.17 for the AAT-. Differences between these correlations indicated that the AAT predicted achievement differentially in the various instructional conditions, and thus, suggested that it might well interact with the response mode variable.

Method

The basic model for this investigation was similar to those recommended by Cronbach and Snow (1969) for ATI studies. Basically two independent variables were manipulated: stress and response mode. The degree to which these variables interacted with sex, and anxiety assigned on the basis of test scores was determined by multiple linear regression techniques.

Procedures

Administration of the procedures of this study took two sessions. In the first of these the AAT, a pretest for the familiar programed material, and some other research scales were administered. The instructional program and posttests were administered in the second session.

Half the Ss who had volunteered for this study were randomly assigned to an induced stress condition. Prior to the beginning of the second session the following instructions were read to this group:

> "Intelligence has been traditionally defined as the ability to learn. In the past ability to learn has been inferred from performance on tests with items of general information, reasoning, etc. . . . This procedure has been criticized since different people do not have the same opportunity to learn these informational items. Our approach to the

> measurement of intelligence is different. Namely, we are inferring intelligence--the ability to learn--by people's actual performance on a learning task. The learning task selected is an instructional teaching machine program. The rationale in back of this procedure is straightforward--the more people learn from this program, the brighter they are. We would therefore like you to do your best on this program. Preliminary results have indicated that this rationale is encouraging. People who have learned much of the program have actually done better in college than those who have done poorly. You will be given a test to determine how much you have learned from this program. It is the score you obtain on this test that, we believe, is related to your ability to learn other things."

Within this stress condition Ss were randomly assigned to one of three presentation modes: two constructed response groups, one with and one without reinforcement, and a reading group. The instructional materials were presented in a booklet format with three frames to a page. The confirmation for one frame appeared in the left-hand margin of the succeeding frame on the next page.

Of the 72 Ss in the stress condition 70 were tested at one time early in the 1968 semester. This was viewed as essential in order to minimize the possibility of feedback between the stress and non-stress groups. Non-stress Ss were typically tested in small groups ranging from one to ten, with the single largest administration consisting of 22 Ss at one time.

Materials

The instructional materials used were identical to those previously employed (Tobias, 1969a, 1969c). The content of the program was described above. The familiar material consisted of the first 54 frames, and the technical material of the succeeding 89 items. A

posttest had been previously developed covering the familiar and technical material. The familiar subtest had an alpha reliability of .66, alpha reliabilities of two technical subtests were: .86 for the items dealing with content requiring S to respond with drawings, and .85 for the verbal items. For the present investigation the latter two subscales were combined into one scale. The complete constructed response program, posttest, and criteria for scoring those responses requiring drawings of ECG tracings can be found in a previous report (Tobias, 1968).

The difficulty of the material was determined by the percentage of correct responses to the program. Previous research (Tobias, 1968) indicated that for the familiar section of the program this percentage was 96.6, and 81.3% for the technical material, a difference significant beyond the .001 level.

As a result of Anderson's (Anderson, Faust, Roderick, 1968) report that their Ss were able to see the confirmation through the paper, blank pages were inserted and bound into the program bookets. The necessity for turning two pages for each frame is likely to have increased the time for the program slightly. The no-reinforcement version of the program was identical to the constructed-response version with the exception of the fact that all of the materials in the left-hand margins containing the correct answers to the preceding frame were cut off.

Subjects

A total of 144 Ss, 80 of whom were female, participated in this study. Subjects were recruited primarily from educational psychology classes at the City College of New York during the Fall, 1967 and Spring, 1968 semesters. Subjects were told that the purpose of the experiment was to study the relationship between programed instruction and the way people think, and were paid six dollars for their participation.

Results

The critical dependent measures in this investigation were the scores attained on the posttest. In order to allow for direct comparability between the means of the technical and familiar subtests, which contained a different number of raw score points, scores were converted to percentages.

The data were analyzed using the multiple linear regression techniques outlined by Cronbach and Snow (1969), and by Overall and Spiegel (1969). A subject's group membership in the experimental stress and response mode conditions was represented by a series of binary vectors. The three response mode conditions were expressed by two vectors: constructed response was coded 1 and 0, no reinforcement 0 and 1, and reading -1 for both vectors. This coding made it possible to replicate previous findings with a comparison between only the constructed response and reading groups by using the first of the two vectors (Cohen, 1968). The AAT scales were included in the model as continuous vectors. Interaction vectors between the experimental variables, and among these

and the assigned variables were the simple products of the component vectors. Since previous research had frequently reported an interaction between sex and anxiety a binary sex vector was added to the analysis.

The initial analysis sought to determine whether anxiety and stress affected the sexes differentially. Interaction vectors were thus developed between sex and the AAT vectors, and between sex and stress. This analysis indicated that there were differential sex effects only for the AAT+ ($F = 12.90$, $p < .001$). Therefore, succeeding analyses of all AAT+ effects were conducted within sex by including the sex, and AAT+ X sex vectors. The full model[1] for the analysis of achievement data included the vectors mentioned above, plus the main effects and only those interaction vectors which were of interest in this investigation. The vectors of interest are shown in Table 1.

The succeeding analysis followed a modified stepdown procedure similar to the one described by Overall and Spiegel (1969), and by Cohen (1968). The significance of main effects was tested by forming a reduced model containing all the main effects, then testing for the significance of each variable by dropping that vector from the model, and testing for reduction in the multiple correlation. This procedure was followed since some of the main effects were intercorrelated (e.g., r between AAT+ and AAT- was -.36) and allowed for the estimation of the percentage of variance contributed independently by any variable

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[1]Beta weights, regression coefficients, and other data pertaining to the full models appear in Appendix A.

Table 1

Multiple Linear Regression Analysis of Achievement Data

		Familiar		Technical	
Effect	df	Percent Variance	F	Percent Variance	F
Response Mode (RM)	2		b	.03	2.88[a]
CR vs Reading	1				
Stress	1	.01	1.37		
AAT-	1				
AAT+	1	.01	1.14	.03	5.43*
Sex	1	.01	1.20		
AAT+ X Sex	1			.08	8.41**
RM X AAT-	2				
RM X Stress	2			.01	1.02
RM X AAT+ X Sex	2				
AAT- X Stress	1	.03	4.01*		
AAT+ X Sex X Stress	1				
RM X Stress X AAT-	2	.04	2.65	.01	1.05
RM X Stress X AAT+ X Sex	2			.03	3.14*

[a] p = .058 Probabilities determined by exact procedure (Veldman, 1968).

[b] F values less than 1 not shown.

*p = <.05

**p = <.01

adjusted for the effects of all other variables. The second modification of the stepdown procedure was to employ the full model, containing all of the vectors including those testing for sex interaction, Ss' SAT and pretest scores for a total of 23 df, in the denominator, rather than only the previous restricted model. This procedure resulted in a more conservative test and is recommended by Cronbach and Snow (1969). The interaction effects were examined by adding vectors in the order in which they appear in Table 1, and their significance tested by comparing them to the prior model, and dividing with the full model in the denominator.

As expected, Table 1, which is reproduced on the preceding page, indicates that none of the main effects achieved significance. The interaction between the AAT- and stress was significant at the 4% level. Inspection of the beta weights for this effect clearly indicates that in this condition anxiety interacted with stress to raise achievement.

For technical subject matter the response mode main effect is of borderline significance, its exact probability being .058. For the comparison between constructed response and reading group, $F = 5.21$ significant at the .02 level. Inspection of Table 2, which is reproduced on the succeeding page, indicates that the constructed response mode resulted in significantly higher achievement than the reading group. This analysis, furthermore, suggests that the borderline significance for the response mode main effect is attributable largely to the presence of the no-reinforcement group whose performance fell between that of the other groups. Contrary to expectation, none of the

Table 2

Means and Standard Deviations, in Percentages, for Familiar and Technical Subject Matter for Different Response Modes

	CR		No Reinforcement		Reading	
Dependent Measure	M	SD	M	SD	M	SD
Familiar Test	63.7	13.7	63.8	12.0	63.8	11.6
Technical Test	63.1	14.3	59.9	13.9	57.4	16.5
Time on Program	86.8	19.1	86.9	17.1	35.2	12.0
Familiar Program	96.5	3.6	96.1	3.2	--	
Technical Program	78.8	9.8	71.6	12.0	--	

results involving debilitating anxiety, as measured by the AAT-, achieved significance. The AAT+ did have both a significant main effect, and interaction with response mode and stress for the technical material. The analysis reported for familiar and technical material was also computed for the amount of time taken to complete the program. This analysis yielded a huge main effect, $F = 155.7$, for response mode. Inspection of the means in Table 2 indicates that these results are attributable to the large difference between the two constructed response modes and the reading group with respect to the amount of time taken. None of the other effects were significant for the results dealing with time.

Data for the percentage of correct responses to the program were available only for the two constructed response groups. These data were analyzed in the same manner as the achievement data. This analysis for the technical portion of the program yielded only one significant effect, namely for the response mode variable ($F = 13.24$, $p < .001$). The mean percentages for the two response groups, reproduced in the last row of Table 2, indicate that the constructed response group with reinforcement had a significantly lower error rate on the technical material than did the no-reinforcement group. For the familiar material there was no significant difference between the groups. Neither the anxiety scales, nor the stress condition singly, or in interaction appeared to have a significant effect on the percentage correct on the program.

Of further interest were some of the intercorrelations among the variables. SAT score correlated .15 with achievement on the familiar

material and .42 with achievement on the technical material, reversing the findings of a previous investigation (Tobias, 1969c). The correlations between the SAT and AAT scores were as follows: AAT- = -.17, AAT+ = .12. The correlation between achievement on the technical and the familiar program was .43.

Discussion

The results of this experiment largely fail to support the expected interaction between achievement from programed instruction, stress, and debilitating anxiety, though an interaction with facilitating anxiety was found. Previous findings dealing with the effects of response mode to programed instruction were replicated. The implications of these data are discussed below.

Response Mode

The present results that constructing responses leads to superior achievement compared to reading technical materials, but not familiar content, replicates previous findings (Tobias, 1969a, c). These data strengthen the conception that S's previous familiarity with the material is an important variable in determining the optimal response mode. On material for which the responses are largely in S's repertory, such as the familiar materials used in this investigation, making an overt response apparently does not lead to a superior association of that response with the particular stimuli present in the program and posttest. The fact that Ss had prior experience with the content was

confirmed again by a pre-test mean percentage correct of 24.7, a bit lower than the previously reported pre-score of 32% (Tobias, 1968). On the technical material, for which a pre-score of virtual zero was found in the prior study, overt responding led to superior learning.

The comparison between the constructed response and reading group strongly supports the response learning interpretation offered in this study. The significance of the findings is obscured by the data for the no-reinforcement group, which fell between the groups with respect to achievement on the technical material. It had been assumed that this condition would be especially advantageous in a study of anxiety and stress. The data indicated that this expectation was not supported by the findings. With respect to the response mode issue, the interpretation of these findings in terms of response learning and the variables affecting the performance of this group are somewhat complex. An overt response was required, though the correct answer was not provided. Despite the fact that explicit reinforcement had been removed, it seems clear that implicit confirmation was present. The hierarchal organization, and frequent review and repetition of the content of prior frames present in linear programs suggests that by going from frame to frame Ss probably receive implicit reinforcement for their responses.

It may well be of theoretical interest to study the effect of eliminating reinforcement from an instructional program. The present findings suggest that this cannot be accomplished simply by removing the reinforcement for preceding frames. Combining a no-reinforcement condition with a scrambled frame sequence would remove not only the

explicit reinforcement, but also the implicit reinforcement present in the frame by frame sequence. Even in such a context, reinforcement would, of course, not have been entirely eliminated, but would be considerably reduced.

In previous research (Tobias, 1969c), achievement on the familiar program was significantly correlated with scholastic aptitude while technical achievement was not. The present investigation essentially reversed these findings. The only available explanation for these data is to be had in the lower variability, with respect to SAT, of the present sample and slightly higher aptitude. For the 144 Ss in this investigation the SAT mean was 528.5 with an SD of 91.5. The comparable data for the prior investigation (Tobias, 1968) were mean 507.5 and SD 105.6.

Time

In accord with the findings of other investigations present results indicate that both the constructed response groups took significantly longer than the reading group to cover the same material. In this study overt responding took 2-1/2 times longer than reading the material. It is sometimes suggested (Roderick & Anderson, 1968) that such findings raise serious questions regarding the efficiency of programed materials. A comparison of time required to achieve mastery is meaningful in those instances when the time required to learn a subject is of equal, or greater importance to the mastery attained. For content such as that employed in this study a greater degree of mastery is well worth the

greater time required. One would assume that even if an ECG technician had to take twice the time to improve his knowledge of subject matter, the increased mastery is well worth the extra time required. On the other hand, asking Ss to skim through materials they have read once may improve their mastery of the subject matter to the same level as working an instructional program, and conceivably at less time. A study of that kind, involving different types of content, might be very revealing with respect to the efficiency issue.

Anxiety, Stress and Programed Instruction

The expected interaction between debilitating anxiety, stress and response mode to programed instruction was unsupported for technical materials, though stress did interact with anxiety to improve achievement on relatively easy, familiar content. Main effects, and interactions for facilitating anxiety were confirmed by the data.

Facilitating anxiety. The AAT+ had a strong main effect, and interacted with stress and response mode. These findings confirmed a tendency noted in previous data (Tobias, 1968). It is difficult to interpret this finding in terms of anxiety theory. Alpert and Haber (1960) conceptualized this scale as a measure of anxiety which facilitates people's performance in achievement situations. The scale contains such items as the following: "The more important the exam or test, the better I seem to do." "I enjoy taking a difficult exam more than an easy one." "Nervousness while taking a test helps me to do better." In view of the content of these items it is not surprising

to note that researchers (McKeachie, 1969) have suggested that AAT+ may be more closely related to achievement motivation than to traditional conceptions of anxiety. Datta (1967) reported that Ss with high AAT- scores tended also to have high scores on other measures of general anxiety while high AAT+ scorers did not. In a factor analysis of 46 other personality scales Datta found that the AAT- and other anxiety scales had factor loadings below -.40 on a psychological well-being factor. The AAT+, on the other hand, had a loading of only .05 on this factor and no higher saturation on any factor other than that defined by the two achievement anxiety scales.

The AAT+ findings make sense when viewed in terms of motivation for academic achievement. From this perspective it is not surprising that Ss with high motivation should achieve more than low scorers, yielding the strong AAT+ main effect Furthermore, it is reasonable to assume that the female Ss in this study, who aspired to be teachers, were more likely to carry out research instructions conscientiously than their male counterparts. The correlation of .50 between the AAT+ and technical achievement for females, compared to -.03 for males, is in accord with these conceptions and explains the strong AAT+ X sex interaction found. These data suggest that the AAT+ may be a fruitful measure to employ in ATI investigations studying academic motivation among females.

Stress and anxiety. The results of this study failed to confirm ATIs between anxiety, stress, and response mode to programed instruction for difficult materials. One possible explanation of these

data is that despite the induction of stress, anxiety was not clearly operative in the situation. The findings of no differences between the stress groups for familiar or technical content support this possibility. There were also no differences attributable to stress on the percentage of correct responses to the program for either type of content, or for the amount of time taken to complete the program. Clearly, the induced stress failed to have any impact. This was somewhat surprising since a preliminary trial of the stress instructions had indicated that they had high credibility for the population sampled. The best way of ascertaining that anxiety is operative in the research task to measure it while Ss are working on the materials, by interspersing a brief anxiety scale with the instructional materials (O'Neill, Speilberger, & Hansen, 1969).

It should be noted that attributing the present findings to the possibility that anxiety was not sufficiently engaged in the research situation can not account for the presence of an interaction between the AAT- and stress for the familiar, easy materials.

A more likely explanation of the present data is that the technical material was not difficult enough to evoke, or maintain, anxiety. The percentage correct for the familiar program, irrespective of response mode, was 96.3 compared to 75.2% for the technical material ($t = 14.45$, $p < .001$). The technical error rate was, thus, over six times higher (3.7 to 24.8) than the familiar. The greater difficulty of the technical material does not, however, answer the question whether an error rate of 25% makes the material difficult enough. In a study by O'Neill,

Spielberger, and Hansen (1969) an interaction between task difficulty and anxiety was found. Their difficult learning materials, consisting of mathematical problems and proofs, had approximate error rates of 73% and 60% for two sections. Error rates for the easy material were virtually zero. The difficult task was made more complex by the fact that Ss could not advance to the next problem until they solved the prior one. Such levels of difficulty are virtually impossible to attain with the usual programed materials, since, while useful for research, they are likely to be useless for teaching. In this study, the no-reinforcement group had an error rate of 28.4% for the technical materials, probably as high as any program designed for the purpose of teaching anything ought to be.

The present findings, combined with the negative results of other attempts to relate achievement from programed instruction to anxiety question whether such an interaction is to be expected in the context of programed, or any other type of instruction. If the ratio of right to wrong responses must be about 2-3:1 in order to demonstrate ATIs with anxiety few instructional methods would qualify for such an interaction. In this study there were clearcut relative differences on acquisition error rates between different types of material, and between response modes, yet the expected anxiety interaction with stress on achievement failed to be confirmed. This evidence strongly suggests that the absolute error rates may well have to be higher than those presently attained in order to find evidence of ATIs with anxiety. In turn this suggests that while such ATIs may be of considerable

theoretical interest, they may <u>not</u> be pertinent to the design of optimal instructional strategies.

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FULL FAMILIAR MODEL 23 Predictors

VARIABLE NAME	CORRELATION X VS Y	REGRESSION COEFFICIENT	BETA
Sex	-0.06653	-8.78100	-0.70674
AAT- (A-)	-0.02668	0.22704	0.09885
Stress (S)	0.10236	-9.76857	-0.79112
Response Mode (RM)	-0.00620	1.56612	0.10356
Response Mode (RM)	-0.00138	3.43197	0.22694
Sex X A-	-0.04586	0.31949	0.68406
Sex X S	-0.06184	12.66888	1.02443
A- X S	0.12619	0.43515	0.94214
A- X RM	-0.01104	-0.02775	-0.04931
A- X RM	-0.01425	-0.16373	-0.28766
S X RM	0.03651	-13.17090	-0.87093
S X RM	0.01653	18.46986	1.22133
A- X S X RM	0.05009	0.50668	0.90035
A- X S X RM	-0.01555	-0.70963	-1.24682
AAT+ (A+)	0.09787	0.18415	0.06354
A+ X Sex	-0.07446	-0.03430	-0.07233
A+ X Sex X S	-0.06969	-0.47207	-0.99686
A+ X Sex X RM	-0.04442	-0.02986	-0.05128
A+ X Sex X RM	-0.07557	-0.02550	-0.04380
A+ X Sex X S X RM	-0.04126	0.00655	0.01128
A+ X Sex X S X RM	0.04162	0.01501	0.02600
Pretest	0.21432	0.21815	0.19322
SAT-Verbal	0.14943	0.01530	0.11297

DEPENDENT
Familiar

INTERCEPT 39.70926

MULTIPLE R= 0.43556 Multiple R^2= 0.18971 SE OF ESTIMATE = 12.17568

SUM OF SQUARES= 4165.03125 ERROR SS= 17789.66797 TOTAL SS= 21954.69922

DF NUMERATOR= 23 DF DENOMINATOR= 120 F= 1.2215

FULL TECHNICAL MODEL

23 Predictors

VARIABLE NAME	CORRELATION X VS Y	REGRESSION COEFFICIENT	BETA
Sex	0.02574	11.55550	0.76746
AAT- (A-)	-0.22096	-0.20368	-0.07318
Stress (S.)	-0.00682	-3.49268	-0.23341
Response Mode (PM)	0.15631	-1.82852	-0.09978
Response Mode (RM)	0.06935	-0.51195	-0.02794
Sex X A-	0.03885	0.24551	0.43378
Sex X S	-0.00183	15.19918	1.01418
A- X S	-0.01086	0.17112	0.30573
A- X PM	0.15745	0.22379	0.32815
A- X RM	0.06453	-0.00531	-0.00769
AAT+ (A+)	-0.10515	-9.87260	-0.53870
A+ X Sex	-0.06593	14.62915	0.79825
A+ X Sex X S	-0.09650	0.26616	0.39028
A+ X Sex X PM	-0.09081	-0.53449	-0.77492
A+ X Sex X RM	0.25385	0.46078	0.13120
A+ X Sex X S X PM	-0.01954	-0.70076	-1.21934
A+ X Sex X S X RM	-0.02031	-0.59011	-1.02828
Pretest	-0.01638	-0.03053	-0.04328
SAT-Verbal	-0.03942	-0.01645	-0.02332
DEPENDENT	0.08302	0.03834	0.05450
Technical	0.15990	0.10674	0.15258
	0.23905	0.12377	0.09046
	0.41643	0.06082	0.37055

INTERCEPT 18.89595

MULTIPLE R= 0.63601 MULTIPLE R^2= 0.40450 SE OF ESTIMATE= 12.64917

SUM OF SQUARES= 13042.12109 ERROR SS= 19200.17578 TOTAL SS= 32242.29688

DF NUMERATOR= 23 DF DENOMINATOR= 120 F= 3.5440